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TESTS ON A NEW TYPE OF MERCURY SWITCHING TUBE, USED AT THE MAGN--ETC(U)

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MAGNATRON CORPORATION OF AMERICA, SAN DIEGO, CALIFORNIA

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TECHNICAL MEMORANDUM

TESTS ON A NEW TYPE OF MERCURY SWITCHING TUBE, USED AT THE MAGNATRON CORPORATION OF AMERICA, SAN DIEGO, CALIFORNIA

This memorandum is intended for the use of others at the Navy Electronics Laboratory and a few outside the Laboratory who may have applications for this type of tube. It is for information only and is not a report on a formal laboratory project.

Preliminary tests were made on an experimental type of mercury vapor switching tube in an attempt to determine if it would be suitable to switch the direct current of the submarine battery bank directly into a transducer load at rates compatible with those now in use in the Lorad program. It is reported that a commercial version of this tube will soon be available and be known as the TRIGNITRON.

INTRODUCTION

At the request of the Bureau of Ships (Rear Admiral L. V. Honsinger's letter to Commanding Officer and Director NEL of 7 January 1958) a group of scientists from NEL visited the Magnatron Corporation of America, San Diego, to discuss items which Mr. Alfred Vang, of that corporation, had proposed for consideration and possible adoption by the U. S. Government. After initial discussions, and since data sheets were not available from the Magnatron Corporation, it was decided to attempt measurement of the characteristics of special purpose mercury vapor switching tubes. These tubes are essentially ignitrons with two mercury pools for electrodes. They are closely associated with the Magna-Quanta converter, a device which is prominent in many of Mr. Vang's proposals. Among other possibilities, it was thought that the special purpose switching tube might have application in Lorad developments.

Data were obtained on the tubes, including photographs of cathode ray oscillograph traces of the switching pulses. This memorandum is a preliminary presentation of the data obtained, and includes a brief description of the switching tube itself.

The tubes observed are of an experimental type manufactured by the Kentron Tube Corporation. Mr. Vang is owner of this Corporation and plans to produce a similar tube under the designation of TRIGNITRON. The production tube is supposed to have characteristics similar to the experimental type, however, it will have a metal envelope instead of the glass found in the experimental type.

Power for the tests was obtained from a 550 volt, 5000 ampere direct current source which is integral with the Magnatron operating setup for welding cans.

The Mercury Vapor Switch Tube:

A close-up view of the switch tube is shown in figure 1. Figure 2 is a view of the tube at time of firing. This tube is similar in a number of respects to existing ignitrons, having no filament, nor conventional electrodes. The electrodes at each end consist of mercury pools which are water cooled. A triggering pulse of approximately 5000 volts potential is supplied from an ignition coil to a separate triggering electrode or element. The triggering pulses are programmed at low voltage by circuitry in the Magna Quanta Converter.

Observed performance in a high speed welding application.

The tubes observed were of an experimental type and used in a welding application at the Magnatron Plant. Figures 3 and 4 show the front and rear view of the Magna Quanta Converter. This device supplies direct current pulses to a large welding transformer shown in figure 5. The repetition rate, pulse length, and amount of energy are all controllable from the Magna Quanta converter. Most of the measurements were made with the repetition rates of 30 to 120 pulses per second, which are those used in the welding application.

It is understood that this configuration of the Magna Quanta Converter contains six of the switching tubes, two of which operate in push pull to perform the work function. The remaining four serve to control the timing, and to extinguish ("Blow-out") the working pair of tubes. A complete circuit was not made available at the time of these observations.

Voltages and Current.

The switching tube was observed to operate very satisfactorily at potentials of 200 to 550 volts d.c. Currents up to and including 200 amperes were observed, with pulse duration of the order of 5 milliseconds.

Switching Rates

The maximum switch rate observed was 900 pulses per second. As mentioned earlier, most of the observations were made using switching rates of 30 to 120 pulses per second, as those rates were being used for the welding applications. However, rates as high as 900 pps were observed in separate test. From what could be determined, the tube was not limited to this rate, but transformers and other components in the triggering circuits had been designed for the low rates and would not trigger the switch tubes above 900 pps.

Mr. Jack Van Eijnsbergen, General Manager of the Magnatron Panel Company, Ltd., Vancouver, B.C., was present during the tests and claims that they have a similar equipment which is capable of switching to 7000 pulses per second.

De-ionization, or Extinguishing time of the switch tube

Under the test conditions, the idealized or minimum extinguishing time for the tube could not be determined. However, it appears to be closely related with the "blow-out" circuitry of the Magna Quanta Converter. Mr. Van Eijnsbergen, claimed that the deionization time was less than 25 microseconds. The 'scope photos of these tests show the extinguishing time to be of the order of 250 microseconds.

Loads used in the tests

Apart from the welding application, test loads used in the observations consisted of heavy copper straps connected directly across the secondary winding of the welding transformer. Two such loads were used; which, external to the transformer but including contact resistance, measured approximately 0.0004 ohms, and 0.001 ohms respectively. The welding transformer (fig. 5) had a turn ratio of 75/1. The secondary was wound with 2 turns of heavy copper bus. Pulses of secondary current in excess of 10,000 amperes were observed. Measurements were also obtained with 5 and 10 ohms resistive loads in series with the switch tube. (no transformer used)

Conclusions:

1. The experimental, mercury vapor switch tube can readily handle pulse currents of 200 amperes.

2. It appears that this tube can operate at switching rates compatible with these in use in the Lorad program, since switching rates of 900 or more pulses per second can be obtained provided proper triggering and "blow out" circuits are employed.

3. Since the tube has no filament nor grid, its useful life should be longer than a conventional thyratron, but similar to an ignitron.

4. The experimental version works well at potentials and currents available from a submarine battery bank.

Recommendations:

1. Obtain data or make similar observations of the production "Trignitron".

2. Test the Trignitron for switching at Lorad frequencies.

3. Test the Trignitron using repetition rates of 60 pulses per second, and combinations which may be attractive in converting D.C. for A.C. power distribution. A suitable combination may possibly be found which will result in a considerable saving of space as contrasted to conventional methods.

FIGURE 1. MERCURY SWITCH TUBE

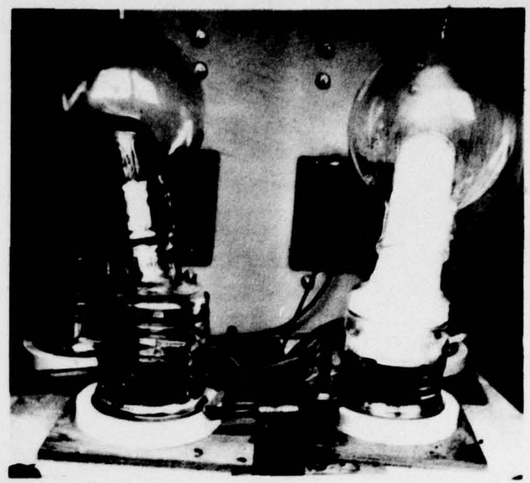


FIGURE 2. SWITCH TUBE IN FIRING CONDITION

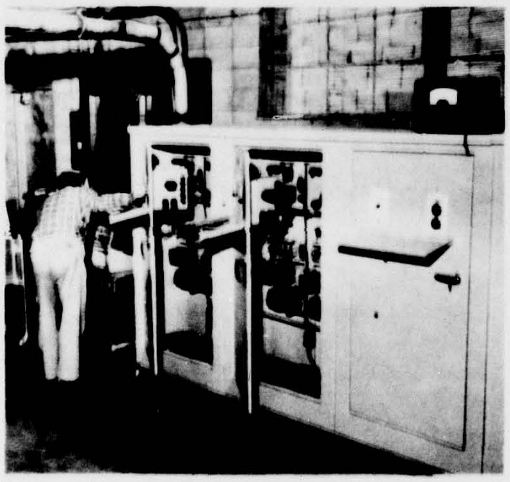


FIGURE 3 MAGNA QUANTA CONVERTER

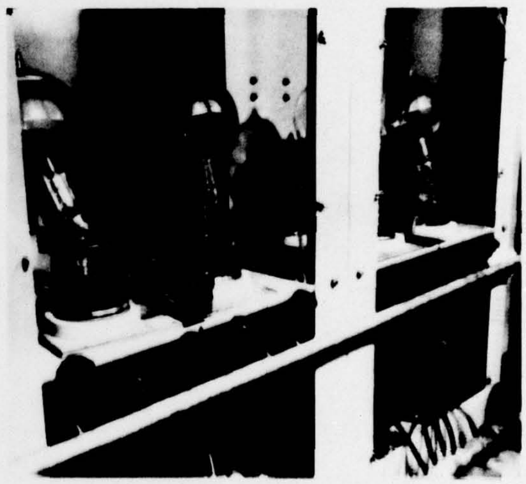


FIGURE 4 REAR VIEW MAGNA QUANTA CONVERTER

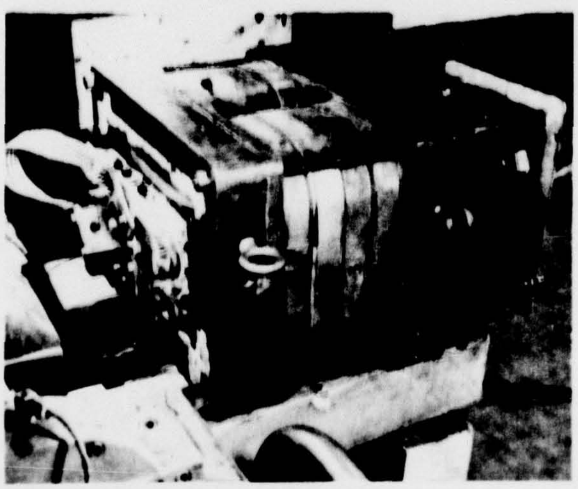
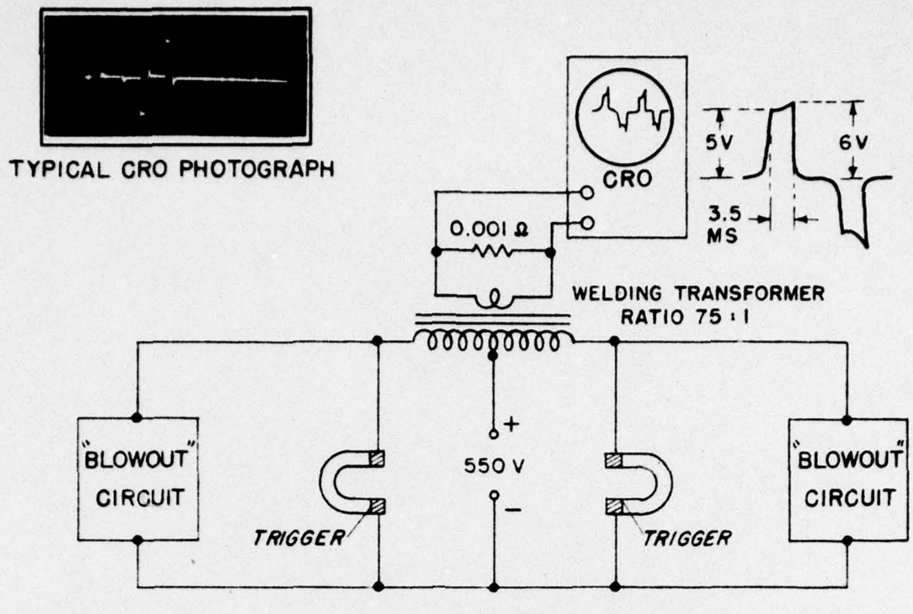
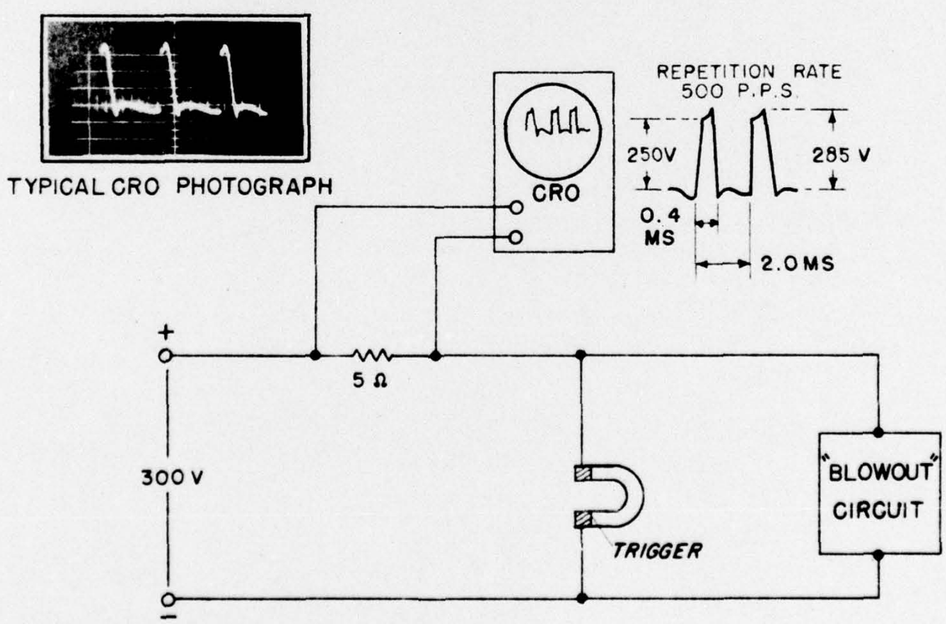


FIGURE 5 WELDING TRANSFORMER



TYPICAL TEST ARRANGEMENT
USING TRANSFORMER



TYPICAL TEST ARRANGEMENT
NOT USING TRANSFORMER